Martin (H.N.) & Donaldson (F. Jr.).

Preliminary Account of Experiments in regard to the Circulatory and Respiratory Changes observed in Animals placed in the Pneumatic Cabinet.

BY

H. N. MARTIN, F. R. S.,

PROFESSOR IN THE JOHNS HOPKINS UNIVERSITY,

AND

FRANK DONALDSON, JR., M. D.,

SOME TIME GRADUATE SCHOLAR IN THE SAME.

REPRINTED FROM

The New York Medical Journal

for May 15, 1886.

Reprinted from the New York Medical Journal.
for May 15, 1886.

PRELIMINARY ACCOUNT OF EXPERIMENTS

IN REGARD TO THE CIRCULATORY AND RESPIRATORY CHANGES

OBSERVED IN ANIMALS PLACED IN

THE PNEUMATIC CABINET.*

By H. N. MARTIN, F. R. S.,
PROFESSOR IN THE JOHNS HOPKINS UNIVERSITY,
AND FRANK DONALDSON, Jr., M. D.,
SOME TIME GRADUATE SCHOLAR IN THE SAME.

The great objection to the use of the pneumatic cabinet has been, beyond doubt, that we had no knowledge of the physiological effect of rarefied and compressed air applied under these conditions on the respiration and circulation; and, indeed, I found myself so timid and embarrassed in its every-day use that I determined to submit no person further to treatment by pneumatic differentiation until I had got at its physiology. I was, therefore, very glad to take advantage of Professor Martin's suggestion that we should conduct a series of experiments upon animals placed in the pneumatic cabinet. The results of these experiments are given very briefly below. A more detailed account of them, with illustrations showing the changes in blood-pressure, pulse, and respiration actually observed, will appear here-

* Read before the American Climatological Association, May 10, 1886.

after. Our experiments have been made on rabbits, and have so far had reference only to changes in arterial pressure, in pulse-rate, in respiratory rhythm, and in the extent of respiratory movements when the air within the cabinet is rarefied or condensed.

The rabbits were chloralized, and a glass tube was placed in the trachea. From the glass tube a rubber tube led to a T-piece. From one limb of the T-piece a tube led to a Marey's tambour, which recorded on the kymograph paper the rate and extent of the breathing movements. To the other limb a tube was attached through which the animal inspired and expired. In some cases this tube opened outside the cabinet and the animal took air into its lungs under the normal atmospheric pressure. In other cases the breathing-tube opened inside the cabinet, and the animal breathed rarefied or condensed air, as the case might be.

A cannula placed in the femoral artery recorded on the kymograph paper the arterial pressure and pulse-rate. Another manometer, placed in communication with the interior of the cabinet, recorded the variations of atmospheric pressure within it. A fourth pen was connected with the clock, and recorded seconds of time on the paper. We are enabled to state our results as follows:

I.—When the animal is breathing air from outside the cabinet, rarefaction of air within the cabinet causes a marked fall of general arterial pressure, but has no influence on the pulse-rate. The fall of pressure lasts a short time only (ten to twenty seconds), and is followed often by a temporary rise above the normal.

II.—This fall of systemic arterial pressure depends on two factors: greater flow of blood to the skin when the air around the animal is rarefied, and greater accumulation of blood in the lungs when they are distended.

III.—Of these two factors, accumulation of blood in the

lungs is the more effective; for, if the animal breathes air from the cabinet and not from outside, rarefaction of air within the cabinet (in this case accompanied by no special expansion of the *thorax*) has but a trivial effect in lowering arterial pressure.

IV.—When the animal is breathing external air, rarefaction of the air within the cabinet usually has no effect upon the respiratory rate or the extent of individual respiratory acts, unless the fall of blood-pressure is considerable. If it is considerable, symptoms of anæmia of the *medulla oblongata* are seen. In most cases there is more forcible dyspnœic breathing; in some there are dyspnœic convulsions similar to those which occur when an animal is bled todeath, and due to the same cause, viz., deficient blood-flow to the respiratory center.

V.—The rapid recovery of general arterial pressure, while the animal is still in a rarefied atmosphere but breathing external air, is probably due to excitation of the vasomotor center, which, as is well known, is excited whenever its blood-supply is defective.

VI.—The brain, inclosed in a rigid box, which is practically unaffected by variations in atmospheric pressure, has its circulation more disturbed in the pneumatic cabinet than any other organ except the lungs.

VII.—Compression of the air within the cabinet, while the lungs are in communication with the exterior air, causes a considerable but transient rise of blood-pressure. This is probably mainly due to the forcing of blood from the cutaneous vessels; but we have not yet had opportunity to thoroughly investigate this point.

VIII.—Compression of air within the cabinet, while the lungs are in communication with the exterior air, slows the pulse as the arterial pressure rises. This is probably due to excitation, by increased intra-cranial blood-pressure, of the

cardio-inhibitory center; but further experiments are necessary before this can be positively stated.

IX.—In certain cases, when the air within the cabinet is rarefied and the animal is breathing external air, the respiratory movements cease altogether for several seconds. As to the cause of this physiological "apnœa" we are not yet ready to form an opinion. It may be due to the extra accumulation of air in the alveoli of the lungs, or to distension of the lungs exciting those fibers of the pneumogastric which tend to check inspiration.

Such, in brief, being the physiological effect of rarefied and compressed air as applied in the Ketchum cabinet, how should this knowledge affect the practical use of this apparatus? It having been found that even very great rarefaction of the air in the cabinet produces but slight effect on the circulation, provided the animal is breathing the air within the cabinet, I conclude:

1. That rarefaction of the air when the person first enters the cabinet (as directed by Mr. Ketchum), in order that the residual air may expand and so drive out any plugs of mucus in the lungs, may be done without danger to the individual. In view of the great and sudden fall of arterial pressure when the animal is breathing outside air and the air within is rarefied, I conclude:

2. That the air in the cabinet should never be suddenly rarefied, and that the motion of exhaust should invariably be slowly made, and the amount of rarefaction small, particularly at the first treatments. This sudden fall of arterial pressure depending as it does upon an increased blood-flow to the skin and an accumulation of blood in the distended veins and lung alveoli, I conclude:

3. That, before deciding a person to be a proper subject for treatment by pneumatic differentiation, *thorough examination* should be made of the *heart;* and that no person

found to have pronounced insufficiency or stenosis of the mitral valve or the slightest tricuspid regurgitation should, under any condition, be placed in the pneumatic cabinet; for it is plain that rarefaction of the air would be most dangerous in such cases. The fall of arterial pressure would seem to depend chiefly upon the accumulation of blood in the lungs, for, if the animal breathes air from the cabinet and not from outside, rarefaction of air within the cabinet has but a trivial effect upon arterial pressure. From this fact I conclude:

4. That the liability to pulmonary hæmorrhage is very slight, though greater perhaps than Dr. Williams has supposed. It having been proved that compression of the air within the cabinet while the animal breathes external air causes a considerable rise in arterial pressure, and slows the pulse from the increase of intra-cranial blood-pressure, I conclude:

5. That old persons, with possibly atheromatous arteries, are not, generally speaking, proper subjects for the pneumatic chamber, especially where their trouble is emphysema or asthma, and compression of the air within the cabinet is made use of in order to assist expiration.

Again, in view of the sudden and pronounced fall in arterial pressure following rarefaction, and of the considerable though transient rise of the same following compression of the air in the cabinet, I conclude that the method of differentiation should be practiced with much care and discrimination in all cases, and that the actual movements of exhaust and compression should be made always very slowly and gently.

Finally, the Ketchum cabinet should be in the hands of careful auscultators only, for in those of the inexperienced or careless great harm may be done.

REASONS WHY

Physicians should Subscribe

— FOR —

The New York Medical Journal,

EDITED BY FRANK P. FOSTER, M. D.,

Published by D. APPLETON & CO., 1, 3, & 5 Bond St.

1. BECAUSE: It is the *LEADING JOURNAL* of America, and contains more reading-matter than any other journal of its class.
2. BECAUSE: It is the exponent of the most advanced scientific medical thought.
3. BECAUSE: Its contributors are among the most learned medical men of this country.
4. BECAUSE: Its "Original Articles" are the results of scientific observation and research, and are of infinite practical value to the general practitioner.
5. BECAUSE: The "Reports on the Progress of Medicine," which are published from time to time, contain the most recent discoveries in the various departments of medicine, and are written by practitioners especially qualified for the purpose.
6. BECAUSE: The column devoted in each number to "Therapeutical Notes" contains a *résumé* of the practical application of the most recent therapeutic novelties.
7. BECAUSE: The Society Proceedings, of which each number contains one or more, are reports of the practical experience of prominent physicians who thus give to the profession the results of certain modes of treatment in given cases.
8. BECAUSE: The Editorial Columns are controlled only by the desire to promote the welfare, honor, and advancement of the science of medicine, as viewed from a standpoint looking to the best interests of the profession.
9. BECAUSE: Nothing is admitted to its columns that has not some bearing on medicine, or is not possessed of some practical value.
10. BECAUSE: It is published solely in the interests of medicine, and for the upholding of the elevated position occupied by the profession of America.

Subscription Price, $5.00 per Annum. Volumes begin in January and July.